Module 23
Multiple, Complex & Critical Lifts

Learning Objectives

By the end of this section, you will:

1. List key safety considerations for tandem lifts.
2. Identify the necessary components of a tandem lift job plan.
3. Understand the role of tailing cranes.
4. Calculate lift points for tandem lifts.
5. Know OSHA requirements for personnel lifts.

Tandem lifts are complex and dangerous.

A job plan must be prepared by a competent and qualified person.

Who should be involved in the job plan implementation?

» Competent person.

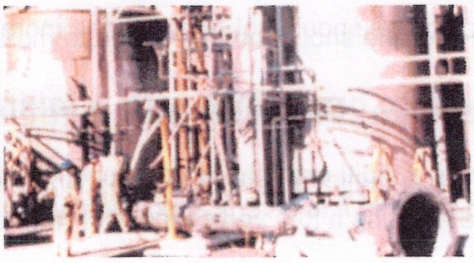
» Qualified person.

» Lift director.

OSHA®
1926.1432

Case Study

Two cranes, one tailing, were supposed to lift this acid scrubbing tower over the tanks of acid. They tried several approaches to keep the load balanced, but straps rubbed against a bolt until one was cut and the other couldn't suspend the weight and failed. If the manufacturer had welded lift lugs at appropriate spots on the tower, the lift would have been much easier.



What should a tandem lift plan include?

» Ground conditions.
» Net load weight.
» Crane capacities.
» Rigging print out.
» Load and crane positions.
» Matched line and boom swing speeds.
» Controlled starts and stops.
» Step-by-step operations known by all.

All cranes must be level and travel must be kept to a minimum.

It is essential for both cranes to lift and lower in unison.

This ensures:

- Adequate (and planned) load share.
- Load stability.

If one end of a load is lifted or landed before the other end, the load distribution may drastically change. This could result in one crane being severely overloaded. When beam lift angle changes, so does load distribution. When load distribution changes, it could be a minor or major problem. Careful and correct load calculations are meaningless if load is not lifted correctly.

The use of more than one crane can result in side loading of the boom.

All operators involved in dual crane picks, should be experienced crane operators.

It is the operators responsibility to exactly follow the signal persons direction unless that direction will lead to an unsafe situation.

The follow crane operator is responsible to match every movement of the lead crane, never lagging behind or getting ahead. It's also the follow crane who will assure that neither crane is side loaded.

Each crane should not be loaded to more than 75% of its rated capacity.

Tandem crane lifts with a tailing crane:

This is a multi-crane lift operation where the "main crane" is lifting a structure from a horizontal position and erecting it to a vertical position with the aid of a "tailing crane".

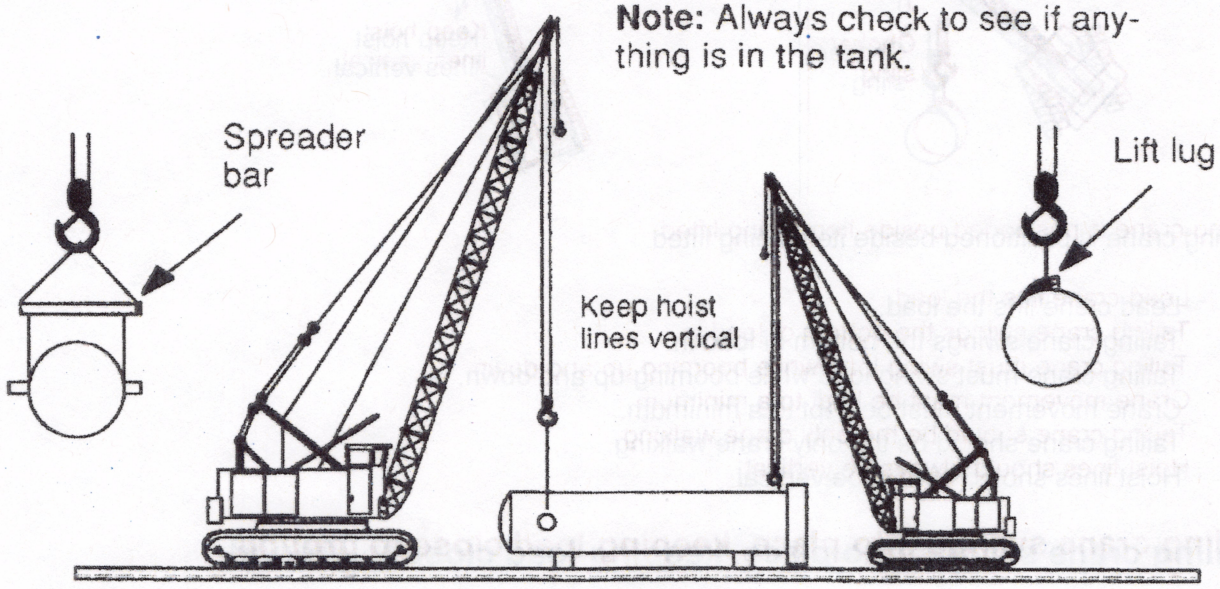
The "main crane" generally will eventually assume the total weight of the structure being erected.

Tailing cranes are often used for erecting vertical elements.

Tailing cranes are typically used for:

- Erecting pressure vessels or tanks.
- Standing long, vertical structural components.

STEP 1:

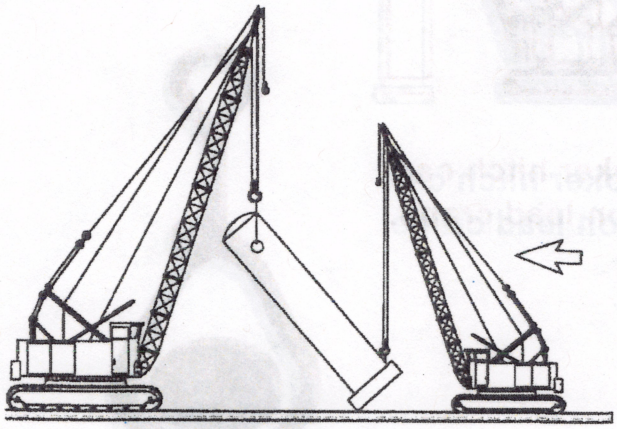


Keep movement of crane boom to a minimum

Tailing crane walks towards lead crane as load is being lifted.

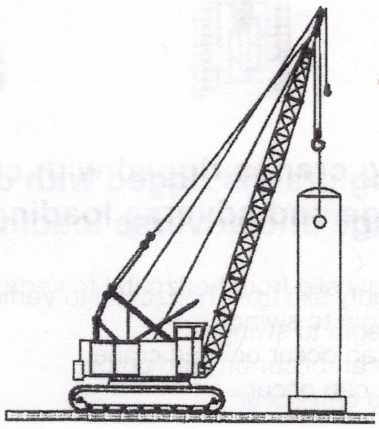
Job of tailing crane is to keep load clear of ground.

STEP 2:

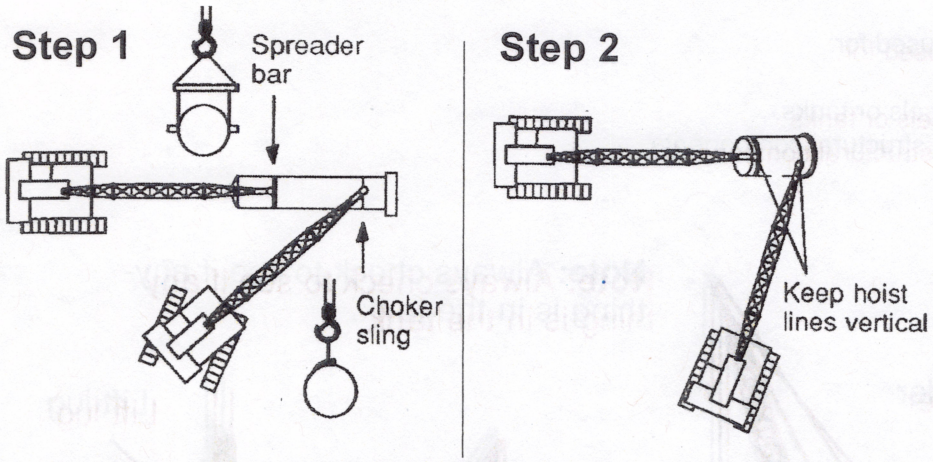


Keep tank end close to ground

STEP 3:



Swinging tailing cranes can also be used.

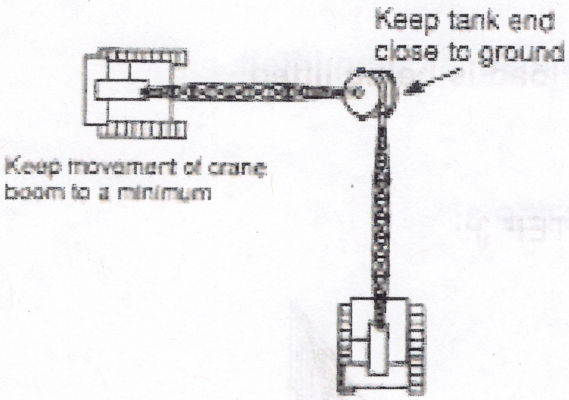


Tailing crane is positioned beside item being lifted.

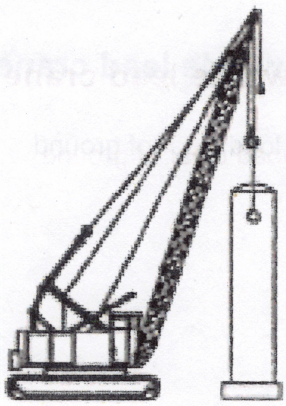
- Lead crane lifts the load.
- Tailing crane swings the bottom of load in.
- Tailing crane must swing load while booming up and down.
- Crane movement must be kept to a minimum.
- Tailing crane should be the only crane walking.
- Hoist lines should always be vertical.

Tailing crane swings into place, keeping load close to ground.

STEP 3:



STEP 4:



Warning: Tailing cranes rigged with choker hitch can result in slippage and adverse loading on lead crane.

- Load can rapidly slip from horizontal to vertical.
- Load could begin to swing.
- Side loading can occur on lead crane.
- Shock loading can occur.

Rigging must be carefully and properly selected.

Crane capacities for tandem lifts are based on freely suspended loads.

What factors should be considered when calculating the capacity of both cranes?

» Load radius.

» Boom angle.

» Boom length.

» Operational quadrants.

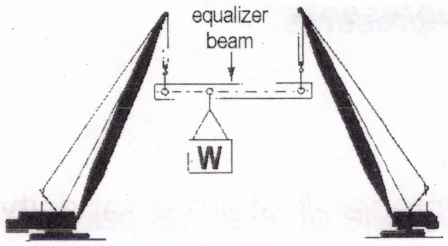
» Rigging components.

» Any other deductions.

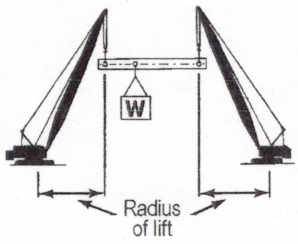
Combined capacities of all cranes must be greater than total load weight.
It is recommended that neither crane in a tandem lift be loaded in excess of 75% capacity.

Calculating Crane Capacity & Pick Points for a Two Crane Pick

CALCULATIONS

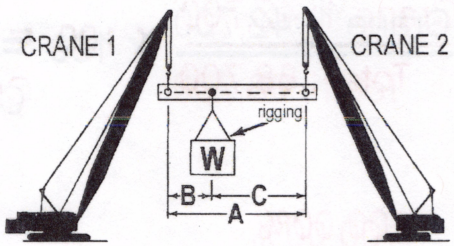


NOTE!
TOTAL CAPACITY of the cranes must be at least EQUAL to or MORE than the TOTAL WEIGHT to be lifted including the load, lifting beams, rigging, hooks, and attachments.



CRANE CAPACITY
is at the RADIUS of the lift.

CALCULATIONS
ALL PIVOT POINTS IN LINE
DETERMINING LOAD ON THE HOOKS



LOAD ON HOOK OF CRANE 1

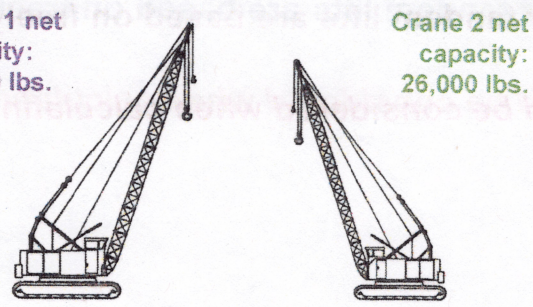
$$= \frac{C}{A} \times (W + \text{Rigging}) + 1/2 \text{ Beam}$$

LOAD ON HOOK OF CRANE 2

$$= \frac{B}{A} \times (W + \text{Rigging}) + 1/2 \text{ Beam}$$

NOTE: Total load on the cranes must include load on the hooks, as above, plus other attachments such as jibs, extensions and hooks

Step 1: Determine net capacity at the most critical position for each crane.



Step 2: Add net capacities of cranes.

Crane 1 net capacity: 42,700
+ Crane 2 net capacity: 26,000

Total net capacity of cranes: 68,700

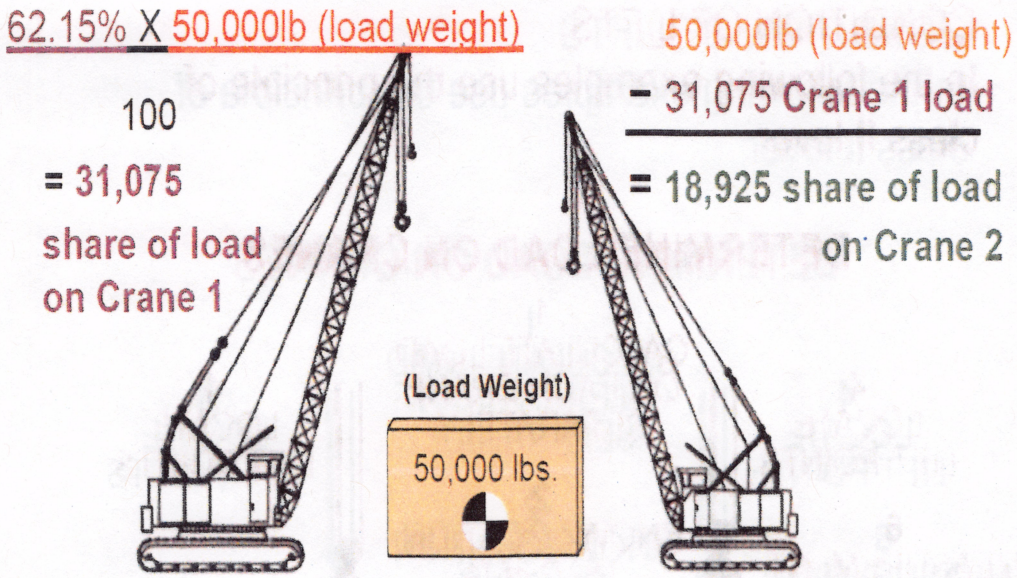
Step 3: Determine percentage each crane represents.

$$\frac{\text{Crane 1: 42,700}}{\text{Total : 68,700}} \times 100 = 62.15\%$$

Crane 1 percentage of total net capacity

100.00%
− 62.15% Crane 1 percentage
37.85% Crane 2 percentage

Step 4: Determine the distribution of load.



Step 5: Ensure cranes are not loaded in excess of 75% net capacity.

$$\frac{\text{Crane 1 load weight: } 31{,}075}{\text{Crane 1 net capacity: } 42{,}700} \times 100 = 72.78\%$$

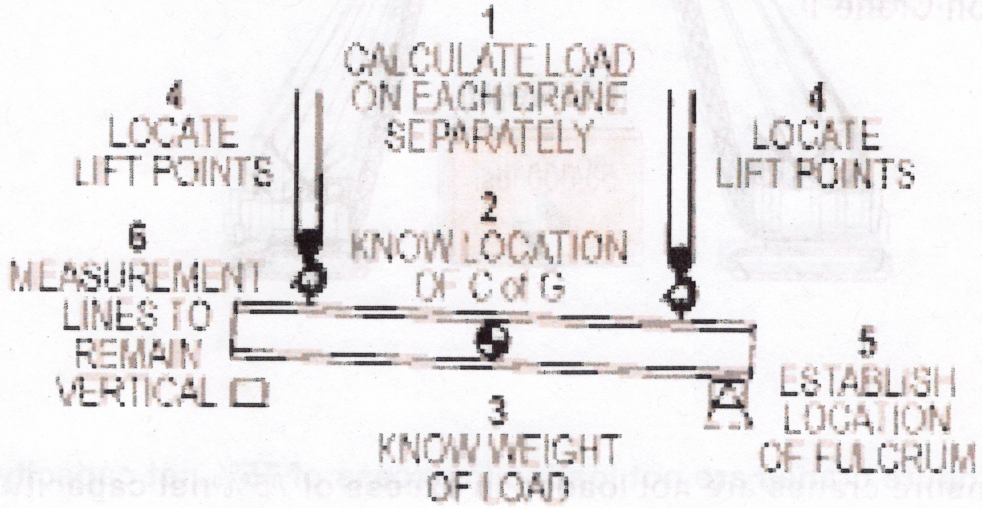
$>$ No crane picks in excess of 75%

$$\frac{\text{Crane 2 load weight: } 18{,}925}{\text{Crane 2 net capacity: } 26{,}000} \times 100 = 72.79\%$$

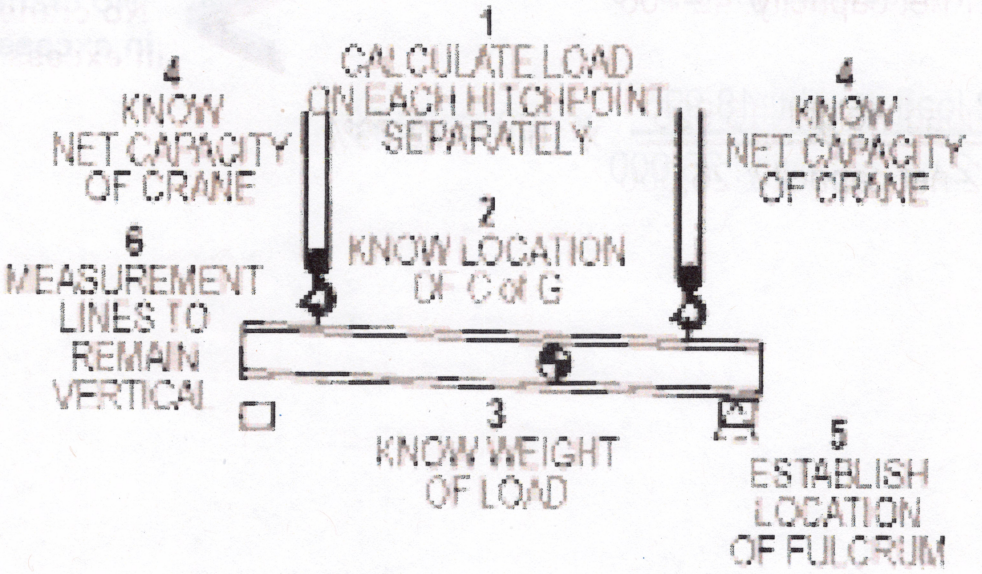
CONDITION OF LIFTS

In the following examples use the principle of class II lever.

DETERMINE LOAD ON CRANES



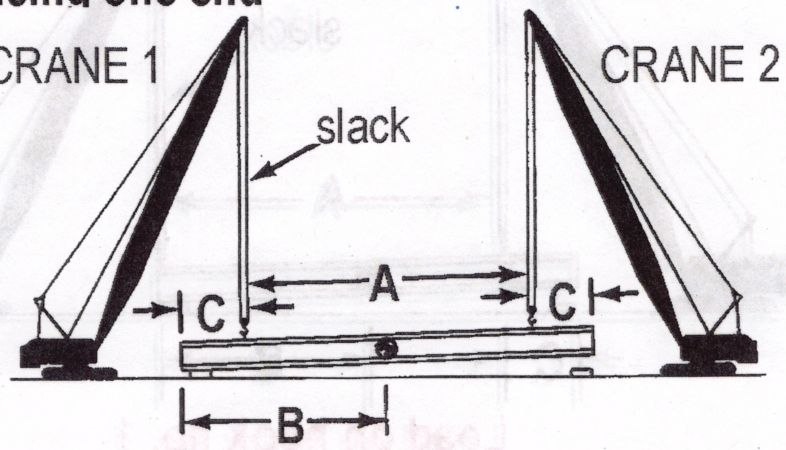
DETERMINE LIFT POINTS ON LOAD



DETERMINING LOAD ON THE HOOKS

LIFT POINTS IN FROM ENDS OF GIRDERS THE SAME DISTANCE.

Raising one end

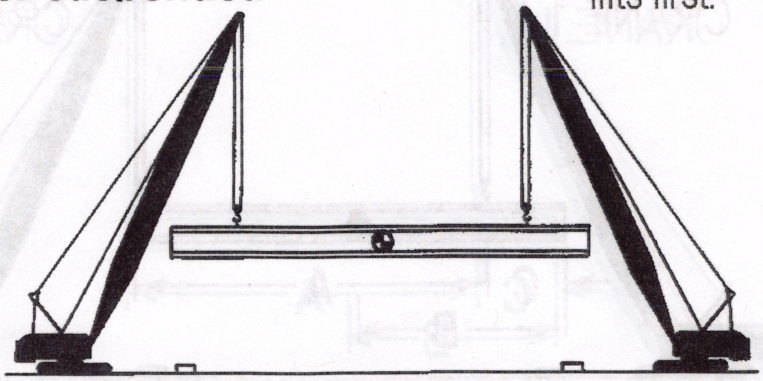


Load on hook no. 2

$$= \frac{B}{(A + C)} \times \text{Weight of Girder}$$

Load on crane 1 the same if it lifts first.

Girder suspended



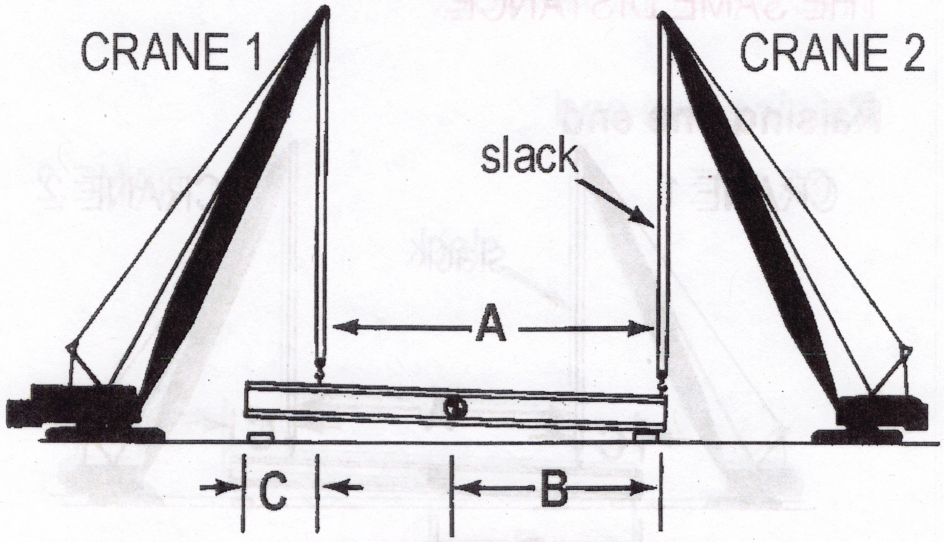
Load on each hook
= 1/2 Weight of Girder

Note: Load on hook higher when one end of **girder is raised than when it is suspended.**

DETERMINING LOAD ON THE HOOKS

LIFT POINT IN FROM ONE END

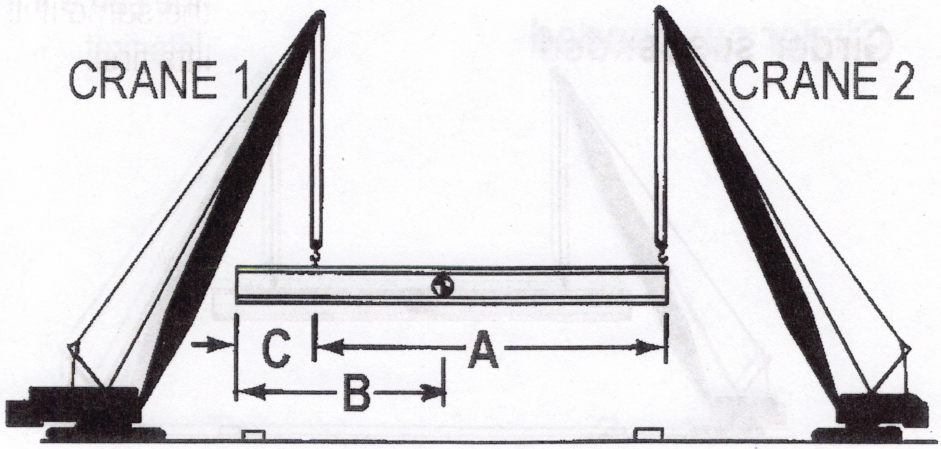
Crane 1 lifts first, places last



Load on hook no. 1

$$= \frac{B}{A} \times \text{Weight of Girder}$$

Girder suspended



Load on hook no. 1 as above

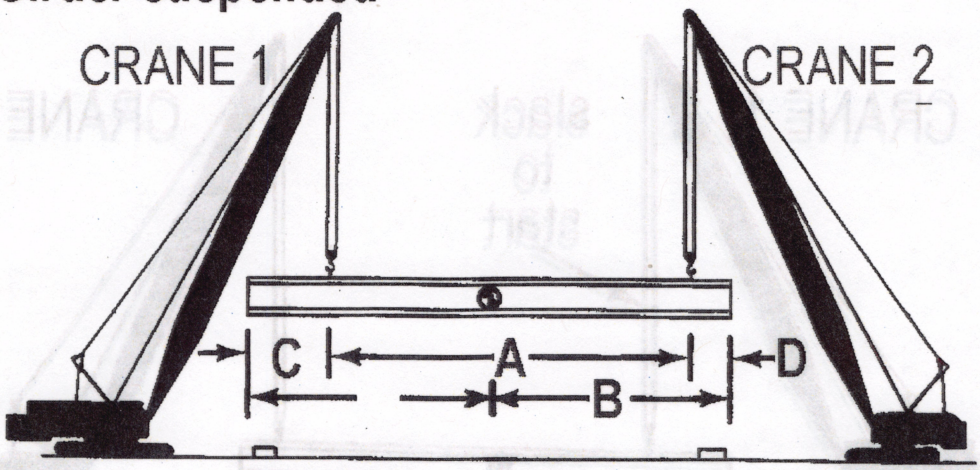
Load on hook no. 2

$$= \frac{(B - C)}{A} \times \text{Weight of Girder}$$

DETERMINING LOAD ON THE HOOKS

LIFT POINTS IN FROM ENDS OF GIRDER DIFFERENT DISTANCES

Girder suspended



Load on hook no. 1

$$= \frac{(B - D)}{A} \times \text{Weight of Girder}$$

Load on hook no. 2

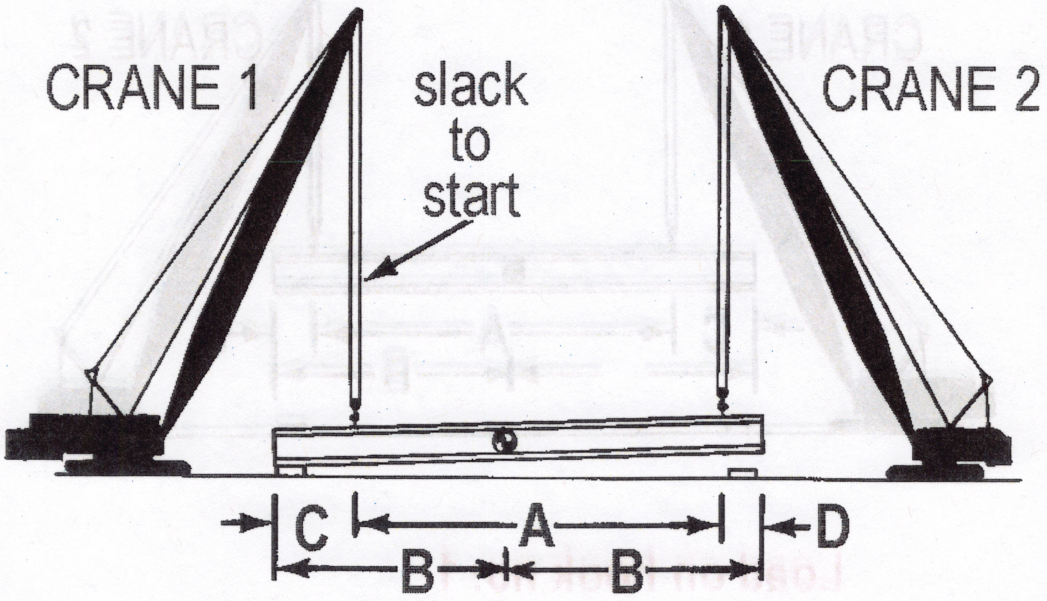
$$= \frac{(B - C)}{A} \times \text{Weight of Girder}$$

NOTE: The load on the crane making the lift first will be INCREASED until the other crane takes the lift.

DETERMINING LIFT POINTS ON GIRDERS

CRANE 1 LARGER THAN CRANE 2

Crane 2 to lift first



$$A + C = \frac{B \times \text{Girder Weight}}{\text{Capacity of Crane 2}}$$

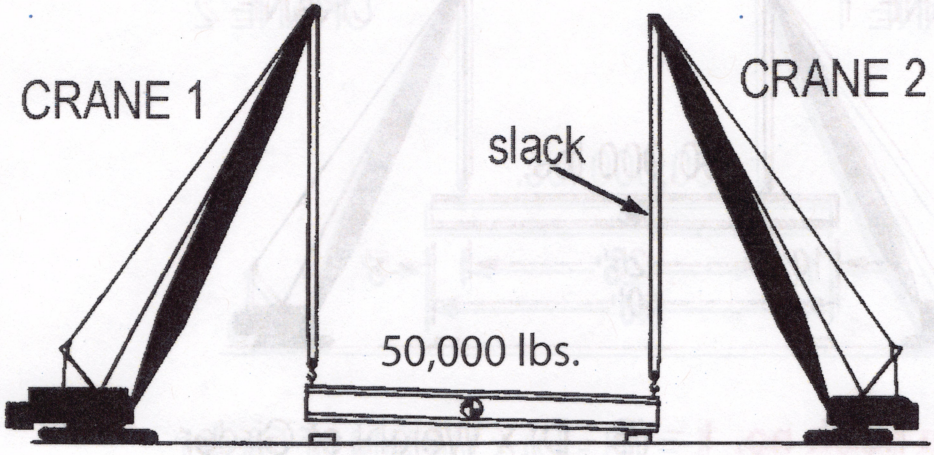
$$A = \frac{(B - D) \times \text{Girder Weight}}{\text{Capacity of Crane 1}}$$

NOTE: Load on crane 2 will DECREASE as crane 1 takes its load.

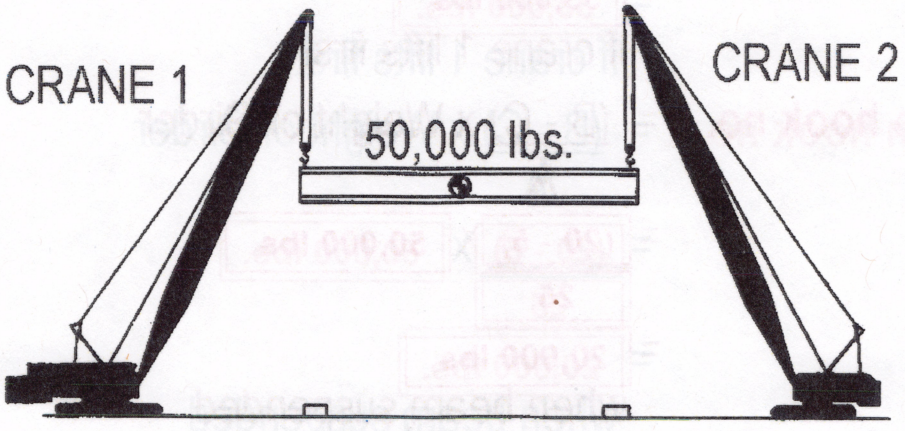
EXAMPLES

DETERMINING LOAD ON HOOKS

1. LIFT POINTS AT END OF GIRDER



Load on hook no. 1
= 1/2 x 50,000 lbs. = 25,000 lbs.
If crane 2 lifts first, load on hook will also be 25,000 lbs.

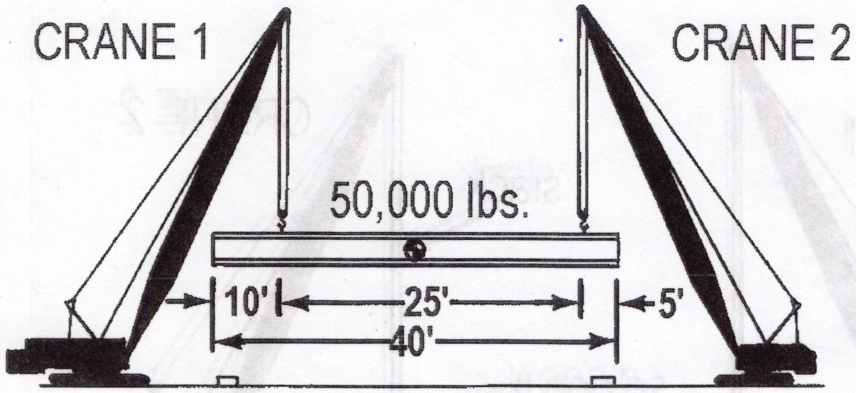


Load on both hooks
= 1/2 x 50,000 lbs. = 25,000 lbs.

EXAMPLES

DETERMINING LOAD ON HOOKS

2. LIFT POINTS IN FROM END OF GIRDER



Load on hook no. 1 = $\frac{(B - D)}{A}$ x Weight of Girder

= $\frac{(20 - 5)}{25}$ x 50,000 lbs.

= 30,000 lbs.
when beam suspended

= 33,000 lbs.
if crane 1 lifts first

Load on hook no. 2 = $\frac{(B - C)}{A}$ x Weight of Girder

= $\frac{(20 - 5)}{25}$ x 50,000 lbs.

= 20,000 lbs.
when beam suspended

= 28,570 lbs.
if crane 2 lifts first

Hoisting Personnel

OSHA 1926.1431

Hoisting employees is prohibited except where the employer demonstrates conventional means would be more hazardous or aren't possible.

OSHA States:

"The use of equipment to hoist employees is prohibited except where the employer demonstrates that the erection, use, and dismantling of conventional means of reaching the work area, such as a personnel hoist, ladder, stairway, aerial lift, elevating work platform, or scaffold, would be more hazardous, or is not possible because of the project's structural design or work site conditions."

Hoisting equipment set-up for hoisting personnel:

OSHA 1926.1431(c)

- Crane must be uniformly level within 1% of level grade.
- Located on footing that has been determined to be sufficiently firm and stable by a qualified person.
- Crane with outriggers or stabilizers must have them all extended and locked.
- The amount of extension must be the same for all outriggers and stabilizers and in accordance with manufacturer procedures.

Hoisting equipment required devices (depending on category of equipment):

- The total load (with the platform loaded, including the hook, load line and rigging) must not exceed 50% of the rated capacity for the crane's radius and configuration.
- When occupied personnel platform is in a stationary working position, all brakes and locking features must be engaged.
- Controlled load lowering system (free fall of the boom hoist line or load hoist line is not allowed.

OSHA 1926.1431(d)(5)(vi)

Cranes with a variable angle boom must be equipped with the following.

- Boom angle indicator.
- Boom hoist limiting device.

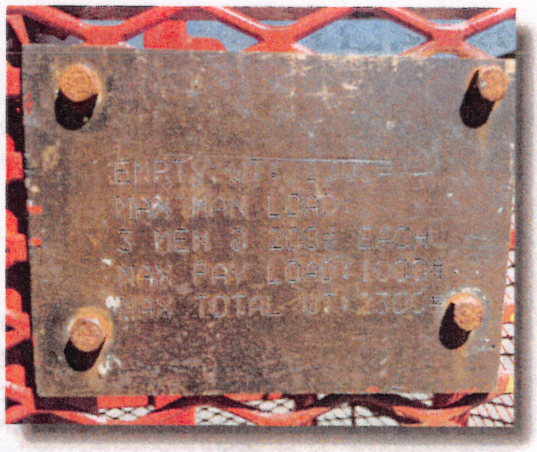
Cranes with a luffing jib must be equipped with the following:

- Jib angle indicator.
- Jib hoist limiting device.
- Direct attachment of a personnel platform to a luffing jib is prohibited.

OSHA 1926.1431(d)(6)

Cranes with telescopic booms must be equipped with:

OSHA 1926.1431(d)(5)(iv)



- A boom length indicator.
- An anti two-block device.

Personnel Platform Criteria

OSHA 1926.1431(e)

- Must be designed by a qualified person.
- Must be designed to restrict tipping of the platform to within 10 degrees of level, regardless of boom angle.
- Must be capable of supporting, without failure its own weight and at least five times the maximum intended load.
- All welding of the platform must be performed by a certified welder.
- A grab rail must be installed inside the platform.
- Access doors/gates must not swing outward.
- Must have a device which prevents accidental opening.
- Employees must be protected by overhead equipment.
- All edges must be smooth to prevent injury.
- Must have a plate or other permanent marking which shows the weight of the platform and its rated capacity.

4 Man Manbasket
48" x 72" Platform
1,000 lb. Load Limit

Personnel Platform Loading

OSHA 1926.1431(f)

- Must not be loaded in excess of its rated capacity.
- Must be used only for employees, their tools, and the materials necessary for them to do their work.
- Must not be used to hoist materials or tools when not hoisting personnel.
- Materials and tools inside the platform must be secured.
- The number of employees must not exceed design limits for personnel.

Fall Protection

- Except over water, employees occupying the personnel platform must be provided and use a personal fall arrest system.
- The system must be attached to a structural member within the personnel platform.

OSHA 1926.1431(k)(10)(i)

Attachments and Rigging

OSHA 1926.1426(g)(1)(i)

- Hooks used in the connection between the hoist line and the platform must be of a type that can be closed and locked.
- The rope bridle used to suspend the personnel platform must have each leg connected to a master link or shackle.
- Rigging hardware must be capable of supporting at least five times the max. Intended load.
- If rotation resistant is used for slings, it must be capable of supporting at least 10 times the maximum intended load.
- Eyes in wire rope slings must be fabricated with thimbles.

Trial Lift and Inspection

OSHA 1926.1431(h)

- A trial lift with the unoccupied platform loaded to a minimum of the anticipated lift weight must be made to each anticipated location at which the platform is to be utilized.
- The trial lift must be performed immediately prior to each shift in which the personnel will be hoisted.
- Safety devices and operational aids required by 1926 CC are activated and functioning properly.
- The platform lift will not exceed 50% of the equipment's rated capacity during the lift.
- Immediately after the trial lift, the competent person must conduct a visual inspection of the equipment and confirm that the test weight has been removed.
- Prior to each lift, the platform must be hoisted a few inches with the personnel and materials on board and be inspected by a competent person.
- In addition, the trial lift must be repeated prior to hoisting employees in each of the following circumstances:
- If the equipment is moved and set up in a new location or returned to a previously used location.
- If the lift route is changed, (unless the competent person determines that the new route presents no new factors affecting safety).

Proof Testing

OSHA 1926.1431(j)

- Proof testing to 125% of the capacity after repairs or modifications.
- The platform must be lowered by controlled load lowering, braked and held in a balanced suspended position for a minimum of five minutes.

Work Practices

OSHA 1926.1431(k)

- Platform occupants, other than signal person, must keep all parts of the body inside the platform.
- Before persons exit or enter a hoisted personnel platform that is not landed, the platform must be secured to the structure where the work is to be performed.
- Tag lines must be used when necessary to control the platform.
- The operator must remain at the controls at all times if the platform is not equipped with controls.
- When wind speed (sustained or gusts) exceeds 20 mph at the platform, a qualified person must determine if in light of the wind conditions, it is not safe to lift personnel.
- Employees being hoisted must remain in direct communication with the signal person or the operator.

- All personnel occupying a personnel platform must use a fall arrest system except over water at which time a personal flotation device shall be worn.
- No lifts shall be made on any other of the equipment's load lines while personnel are being hoisted except in pile driving operations.

Traveling with Hoisted Employees

OSHA 1926.1431(n)

- Hoisting of employees while the equipment is traveling is prohibited, except for equipment that travels on fixed rails.
- Where employees are hoisted while the equipment is traveling the equipment must be restricted to a fixed track or runway.
- Traveling with the platform must be limited to boom length, which must be parallel to the direction of travel.
- When traveling with equipment hoisting personnel there must be a trial run performed to test the route of travel before employees are allowed to occupy the platform.
- A pre-lift meeting must be attended by all personnel involved in the operation prior to the lift to review the procedures and requirements that will be followed.
- Hoisting personnel within 20 feet of a power line that is up to 350kV, and hoisting personnel within 50 feet of a power line that is over 350kV, is prohibited.

What can and can't be brought onto a platform?

» 1926.1431(f)(2)(i) Personnel platforms must be used only for employees, their tools, and the materials necessary to do their work. Platforms must not be used to hoist materials or tools when not hoisting personnel.

What are the requirements for hooks and other detachable devices?

» 1926.1431(g)(1)(i) Hooks used in the connection between the hoist line and the personnel platform (including hooks on overhaul ball assemblies, lower load blocks, bridle legs, or other attachment assemblies or components) must be:

- Of a type that can be closed and locked, eliminating the throat opening.
- Closed and locked when attached.
- Shackles used in place of hooks must be of the alloy anchor type, with either: A bolt, nut and retaining pin, in place; or of the screw type, with the screw pin secured from accidental removal.

What does OSHA require for a trial lift?

» 1926.1431(h)(1) A trial lift with the unoccupied personnel platform loaded at least to the anticipated lift weight must be made from ground level, or any other location where employees will enter the platform, to each location at which the platform is to be hoisted and positioned. Where there is more than one location to be reached from a single set-up position, either individual trial lifts for each location, or a single trial lift, in which the platform is moved sequentially to each location, must be performed; the method selected must be the same as the method that will be used to hoist the personnel. The trial lift must be performed immediately prior to each shift in which personnel will be hoisted. In addition, the trial lift must be repeated prior to hoisting employees in each of the following circumstances:

- The equipment is moved and set up in a new location or returned to a previously used location.
- The lift route is changed, unless the competent person determines that the new route presents no new factors affecting safety.

Notes: